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PROJECT GEMINI

FACT SHEET

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FACT SHEET

INTRODUCTION

One year ago last May, within three weeks after the Nation's first manned space flight -- the suborbital flight of Astronaut Alan B. Shepard, Jr., aboard "Freedom 7" -- President Kennedy in a special address to Congress established manned lunar landing as our National goal. The President's statement was followed in less than two months by the Nation's second manned space flight, that of Astronaut Virgil I. Grissom in "Liberty Bell 7". Since then, several orbital flights have been made, unmanned instrumented flights at first, the primate-inhabited two-orbit mission, the three-orbit flights of Astronaut John H. Glenn, Jr., in "Friendship 7" and Astronaut M. Scott Carpenter aboard "Aurora 7", and the six-orbit flight of Astronaut Walter M. Schirra, Jr., aboard "Sigma 7."

These flights came after an intensive period of research and development which in three years produced a manned spacecraft, flight operational techniques, a worldwide tracking and instrumentation network, trained flight and ground crews, and military launch vehicles adapted to manned space flight.

NASA MANNED SPACECRAFT CENTER

Manned space flight has come into its own as a major part of the Nation's total space flight program. The management organization for this effort is the NASA Manned Spacecraft Center, Houston, Texas, (formerly the Space Task Group, located at Langley Air Force Base, Hampton, Virginia.)

The Manned Spacecraft Center, under the direction of Dr. R.R. Gilruth, the Nation's experienced management agency in the field of manned

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space flight research and development, has been responsible for Project Mercury since its inception. The Center has the responsibility for developing manned spacecraft, for training space flight crews to man these craft, and for conducting space flight missions. The Center is also conducting Projects Gemini and Apollo for the development of space flight techniques, for the acquisition of knowledge, and for the use of man in exploring space for the generation of better understanding of the universe in which we live.

NASA has broken the manned space flight job down into several projects and has further broken them down into specific and particular missions to be carried out under the Mercury, Gemini and Apollo projects. NASA has defined the job in terms of the manned spacecraft and its associated equipment, in terms of the launch vehicle and its various stages, and in terms of ground equipment, launch facilities and tracking stations required for the operation.

Project Mercury has provided the initial step upon which future space flight programs are being built. In bringing Mercury to this stage, NASA has acquired a large fund of both general and detailed knowledge that should do much to help advanced manned flight programs.

Project Gemini, the Nation's next step into space, will employ a two-man spacecraft for long-duration missions and for rendezvous and docking experiments. This program is now in the design and construction phase. Lessons learned from Project Mercury will be utilized to provide significant increases in space flight duration and maneuverability. Gemini will provide flight experience and technical knowledge that will be applied to Project Apollo, which according to present estimates will reach the test-flight stage by about 1965, and to more advanced space flight missions.

OBJECTIVES

As an intermediate step between Mercury and Apollo, the objectives of Project Gemini are:

1. To provide early manned rendezvous capability by (a) developing techniques, (b) assessing pilot functions, (c) developing propulsion, guidance and control, (d) developing pilot displays, and (e) training pilots and providing them with rendezvous experience.

2. To provide long-duration manned flight experience by (a) studying effects of weightlessness, (b) determining physiological and psychological reactions to long-duration missions, and (c) developing performance capabilities of the crew.

These objectives have tremendous possibilities and will give NASA the necessary experience to go to the moon, while the experience and knowledge of rendezvous techniques has other potential uses such as extra vehicular capacity, supply and crew transfer, a taxi to ferry personnel to orbiting space stations, to approach and look over objects orbiting in space, and later, maintenance and crew rescue.

For the Gemini program during fiscal year 1963, about $250 million will be devoted to development of the Gemini spacecraft for operational support including flight control, Weather Bureau support, recovery and data processing. Included also will be support developments such as associate contracts and the Titan II launch vehicle and the Agena D target vehicle.

The entire budget for Gemini now stands at about $700 million. This $700 million covers the entire operation: launch and target vehicles, spacecraft, support equipment, prelaunch preparations and checkout, flight monitoring, data reduction, ground training equipment, and the training process -- everything.

The NASA Manned Spacecraft Center's Project Gemini -- unnamed then -- was approved on December 7, 1961, as a plan to "extend the Project Mercury effort with the development of a two-man spacecraft." NASA announced on January 3, 1962, that the program was officially designated as "Project Gemini" after the third constellation of the zodiac featuring the twin stars, Castor and Pollux.

Since the Gemini announcement, NASA has named the McDonnel Aircraft Corporation of St. Louis, Missouri, as prime contractor of the two-man vehicle.

McDonnell has been the prime contractor for the design, development, and construction of the Project Mercury spacecraft for the NASA Manned Spacecraft Center since February 1959. McDonnell's responsibility on Project Mercury has included the production of 20 spacecraft. For Project Gemini, McDonnell will build 13 spacecraft, 12 of them operational.

McDonnell showed the first Gemini spacecraft mock-up at the St. Louis plant on March 29, 1962.

Twelve flight spacecraft have been ordered from McDonnell; 12 flights are planned. The 13th spacecraft will be placed in a test chamber for systems ground tests -- everything except weightlessness.

When the program was named, James A. Chamberlin, former chief of Manned Spacecraft Center's Engineering Division, was appointed Project Gemini Manager. Andre J. Meyer, Jr., then the Assistant Chief of the MSC Engineering Division, was named Chief of the Gemini Project Administration Office in March 1962.

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Others named to the staff were Duncan R. Collins, Spacecraft Manager of the Gemini Management Office; Willis Mitchell, Launch Vehicle Manager; and Wilbur H. Gray, Head of the NASA Field Representative Office at McDonnell Aircraft Corporation. Project Engineers are Jerome B. Hammack, Homer Dotts, Walter J. Kapryan, and Rodney G. Rose. These and a staff of 95 other top MSC personnel constitute the Gemini Project Office.

GEMINI SPACECRAFT

Basically, the Gemini spacecraft will be similar in shape to the Mercury craft. It will be based on the current Mercury configuration, but it will weigh approximately twice as much as Mercury, will be about 20 per cent larger and will have about 50 per cent more volume. The Mercury craft was about six feet wide at the base as compared with the Gemini vehicle which will be about seven and one-half feet wide at the base (16 inches wider).

The Manned Spacecraft Center's Project Mercury experience has enabled its scientists and engineers to improve the new vehicle's design in many ways. Many of the advanced concepts in systems engineering for spacecraft have already been explored.

A space between the outside of the pressurized crew compartment and the external surface of the craft will house instrument packages, electronics gear and landing gear. This double construction will also serve effectively against micrometeorite damage.

Only the systems directly connected with the crew will be housed inside the crew compartment -- within the pressurized area -- such as the environmental control system, ejection seats, food and waste equipment, microphones, speakers, the instrument panel and guidance controls. The "packaging" of components has resulted from the compactness of the Mercury spacecraft; its small volume and systems redundancy required the "stacking" of components in Mercury, one upon the other inside the pilot's compartment.

Long checkout and rework periods are presently required, particularly in the event of systems failures. In the new Gemini design with many of the flight systems placed outside the crew's pressure vessel, major components will be arranged in easily-removed, replaceable modules, thereby reducing maintenance and checkout time. Whole systems, even the Environmental Control System, can be pulled out -- in the event of malfunction -- and replaced with another "packaged" system without the crew compartment being opened and without the countdown being interrupted for long periods of time.

Due to more rapid checkout periods at the Cape, the Gemini spacecraft should require a little over two and one-half months testing prior to a missions. Experience with the Mercury spacecraft has been six to seven months of checking prior to a launch.

TITAN II

The Gemini launch vehicle will be a slightly modified Titan II, a second-generation launch vehicle, constructed by the Martin Company and provided for the Gemini program by the Space Systems Division of the United States Air Force. Since the Titan II is primarily an Air Force vehicle, NASA deals with the Martin Company through the Air Force. Titan II was selected because of its simplified operation and its greater lifting capability and for its availability at the time of selection.

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Titan II employes storable hypergolic (self-igniting upon mixing) propellants, permitting a much shorter countdown period prior to launch than presently required in the Mercury-Atlas program. Shorter countdowns are necessary because of the close schedule which must be followed in order to successfully complete the rendezvous mission after the rendezvous target is orbited.

On December 28, 1961, the Titan II launch vehicle was successfully captive-fired (test-fired while being held in place) for the first time. This test was conducted at the Martin Company's Denver (Colorado) facilities. The test was also a checkout of launch equipment intended for use in launch operations.

Earlier, on October 6, an Air Force Titan I was launched downrange from the Cape carrying the Titan II guidance system for initial checkout purposes.

Major changes in the Gemini launch vehicle version over the Titan I weapon system include: the use of hypergolic fuel rather than liquid oxygen and RP-1 which is still used for Titan I propulsion; modification of the flight control systems to improve pilot safety; and a malfunction detection system which will warn the pilots of equipment failure such as rupture of a fuel container or divergence of pitch.

On March 9, 1962, Titan II underwent a successful 20-second full-power, captive firing at Cape Canaveral and was considered ready for its first flight. During the captive test, the Titan II vehicle produced 439,000 pounds of thrust with its first stage. The second stage would have added another 100,000 pounds of thrust for a total thrust poundage of 539,000.

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One week later, on March 16, the Titan II was launched successfully for its first test flight from the Cape; it was termed successful. The launch vehicle climbed from the pad above a rosy cloud, its storable, hypergolic fuels emmiting a stream of hot, clean gases rather than flame and smoke. The Titan II contract for development of the vehicle was initiated less than two years prior to that first flight.

The second Titan II flight occurred on June 7, 1962, but the second stage produced low thrust which resulted in the termination of the flight at reduced range. The third flight was made on July 12, and was successful. The fourth attempt was made later in July; this flight was terminated due to a premature shutdown of the second stage.

The present Air Force launch schedule for Titan II test flights appears to permit a very large number of instrumented flights prior to the time when NASA needs it for the Gemini flights.

Problems of launch vehicle-spacecraft integration between the Titan II and the Gemini craft should be somewhat less than in the Mercury-Atlas program. Mercury experience now guides the thinking; there was no experience to build upon during early Mercury planning.

The overall length of the Gemini-Titan II combination will be 110 feet. The Titan II alone is 90 feet long; its first stage is 70 feet long and its second stage is 20 feet long. The vehicle is ten feet in diameter from the thrust section to the spacecraft adapter section.

The modifications necessary at Cape Canaveral for the launch of the Gemini-Titan combination will primarily concern launch complex 19. The Titan

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erectable tower is considerably different from the Atlas gantry. This erectable tower contains the white room and other necessary equipment just as does the Atlas gantry; however, the tower is lowered to a prone position for launch of the Titan rather than being rolled away.

AGENA D

The Agena D vehicle, a modified version of the Agena B used in Ranger, Mariner, Midas, and Discoverer projects, will be used as the target vehicle for Gemini rendezvous and docking. The vehicle is about 32 feet long and 60 inches in diameter. The Agena is produced by the Lockheed Aircraft Corporation and developed by the USAF for use in Air Force programs with first-stage Atlas and Thor launch vehicles.

About one fourth of Lockheed's employees now work on space programs. In addition to the Lockheed Missiles and Space Company, other Lockheed divisions are also working with NASA. Lockheed-California Company scientists are studying space logistics, docking techniques, and lunar base supply problems. Lockheed Electronics Company supplies transmitters for satellites and recorders for space vehicles. Lockheed Propulsion Company is an important subcontracting participant in the Mercury and Apollo programs. Lockheed-Georgia Company is carrying on nuclear radiation and cryogenics studies and is a Saturn subcontractor.

Few Space Age products have shown the versatility of the Agena space vehicle. Lockheed has built scores of Agenas and has now developed a standardized Agena to extend the usefulness through the 1960's. NASA has scheduled Agena for roles in over a dozen missions - Ranger lunar voyages, Mariner planetary fly-bys, Rebound and Echo II communications programs, and orbiting geophysical, astronomical, and meteorological laboratories, in addition to use as the Gemini target vehicle.

Early in 1960, NASA decided to use the Thor-Agena B and the Atlas-Agena B combinations to fulfill its requirements in this weight class rather than to develop similar vehicles in parallel. Following procurement of the Agena, NASA made minor modifications to the vehicle which resulted in a cleanly-designed parting plane for the attachment of a variety of payloads to be carried.

During the next few years, the Atlas-Agena and Thor-Agena vehicles will serve as workhorses for heavy-duty missions until the Centaur and Saturn vehicles are operational. Atlas-Agena vehicles are normally launched from the Atlantic Missile Range, while Thor-Agena craft are sent up from the Pacific Missile Range.

The Atlas does not provide sufficient power to insert the Agena into orbit. The Agena will then start -- by means of its hypergolic fuel supply -- and power itself into orbit, using the Atlas as a launch platform. When desired orbital conditions are obtained, the Agena engine will be shut down and be preserved for later use.

After the Agena target is in orbit, Mercury ground tracking stations will determine whether or not the Agena is operational and is in the proper orbit for rendezvous. There will be a several minute window when Gemini might be launched and be in close proximity to the Agena. But by firing up the Agena and changing its orbit to conform more closely with the Gemini orbit, the window can be extended in excess of four hours. The Gemini will either be launched during this window or will wait for a corresponding window at least one day later.

If the two vehicles were launched into their orbits 180 degrees apart -- on the opposite sides of the earth from each other -- it would take the

Gemini 36 orbits (54 hours) to overtake the Agena. Thus, launching of the Gemini within the prescribed window is necessary.

The Agena can wait in orbit for five days. As planned, though, it will go up one day and be followed by the piloted Gemini craft in about 24 hours.

According to the determination of the window, the Gemini vehicle will be launched. Launch-timing and mid-course corrections will be such that the manned spacecraft will be placed in close proximity to the Agena. The Gemini vehicle will be in an 87 to 150 miles altitude orbit. The astronauts will control the Gemini vehicle in an approach manner in accordance with instructions from ground tracking stations and into a terminal docking position with the Agena.

As the Gemini closes to within 250 miles of the Agena in orbit, the manned spacecraft may be guided toward its target automatically by aid of an onboard radar and computer, or the astronaut may use the radar system and control the spacecraft manually. Adjustments for the orbital path will be made from ground control stations as far as the Agena is concerned. The Agena will have a cold gas (nitrogen) system for stability and control thrusts. Similar adjustments will be made for the spacecraft, either manually or by earth-control in order to successfully complete the rendezvous.

After using the radar system aboard the Gemini to close within about 20 miles, the astronauts should be able to see the high-intensity, flashing light aboard the Agena for optical tracking.

The two vehicles, rushing through space at some 18,000 miles per hour, share a gentle difference in speed of only one to two miles per hour. The

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flexibility of this speed is ideal for threading the nose of the Gemini through the docking collar of the Agena. Final docking procedures will probably be accompanied by activating the propulsion units aboard the manned craft for the contact. The spacecraft will use small thrusters of 25 and 100 pounds of thrust with hypergolic propellants -- not the hydrogen peroxide as is used for Mercury spacecraft.

There is a possibility that Manned Spacecraft Center engineers will mount a television camera on the Agena or in the spacecraft so that ground controllers in Mission Control Center can monitor the docking procedures. This point in planning is not yet definite.

The astronauts will be able to see the Agena straight ahead of the Gemini through the flat glass of the windows in their hatches. An index bar of the spacecraft will engage the "V" notch or slot in the docking collar on the end of the Agena. The collar area will be fitted with both solid and buffer areas. Upon contact with the cone of the Gemini craft -- if the match has not started perfectly -- both crafts will turn slightly and conform. If the Agena is bumped away, the astronauts will merely set up for another attempt. Pulse jets will give the Gemini a small kick at a time.

During the latching part of the docking phase, when clamps inside the Agena collar grab the Gemini nose cone and pull it into a latched position, the instrumentation wires will also be connected. The astronaut will then be able to observe the "health" of the Agena -- fuel, connection, etc. Facilities aboard the Gemini spacecraft will enable the pilot to start the Agena propulsion system.

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Since the Gemini will nose into the front collar end of the Agena, the Agena thrust will be provided from the opposite end; this will cause the astronauts to be propelled backward when using Agena power for maneuvering. The "eyeball out" forces will be less than two g and are not considered a problem of any kind.

The Mercury spacecraft is too small to contain rendezvous equipment and the necessary additional maneuvering propulsion system and fuel for such rendezvous and docking practice.

The Agena engine will have multi-restart capability; thus, when the Gemini arrives in orbit, it will have another engine waiting there ready to supply power for orbital maneuvering. Here the engine can be used for adjusting the orbit, extending the apogee of the orbit, or for changing to another orbit. All the experiments that will be performed at this phase of the mission have not yet been documented.

With the ability to maneuver in space, the Gemini pilots might use the Agena to thrust their Gemini craft into a different orbit for better choice of their landing site; they might control their direction for a landing in northern Texas or southern California even though their craft were not going to pass over that region during that orbit.

This then is the potential for deep space missions, designed for and versatile enough for a variety of missions and work in space.

Manned Spacecraft Center astronauts cannot wait to learn rendezvous techniques while in lunar orbit during an Apollo mission. They must first

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simulate these maneuvers on the ground, then rehearse and practice them many times in space before they can be assured that the techniques are perfected.

Gemini rendezvous experiments are particularly important since lunar orbital rendezvous will be the method employed for carrying out final phases of Project Apollo multi-manned, lunar landing and earth-return missions. For such a mission, the manned Apollo spacecraft will be launched into lunar orbit by the advanced saturn launch vehicle.

The Apollo craft will remain in orbit, while a two-man Lunar Excursion Vehicle will be detached, will depart orbit, descend for lunar-landing and excursion, and launch itself back into lunar orbit for rendezvous with the mother craft. This method was chosen in July 1962 to meet the national goal of manned lunar landings prior to the end of this decade.

The problems of flight control in "real" time for the Gemini program should be intermediate in severity between those for Mercury and Apollo. Experience with Mercury and Gemini in controlling long-duration missions should contribute both knowledge and actual operational experience that will be valuable for the solution of Apollo flight-control problems and the provision for the Gemini two-man crew will allow more pilots to acquire actual space flight experience.

Since Mercury flights have shown that man can operate satisfactorily in a space environment, and since the second Gemini crew member will provide backup for the first, it is planned that Gemini will have less automatic sequencing of flight modes than did Mercury. Operations with man in the

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role of mode selector and acting as sensor operator in the rendezvous missions should again provide experience and knowledge that will increase confidence in the role to be played by man in Apollo.

As another change, Gemini will not have a long, heavy escape tower on top to change structural vibration modes of the combined launch vehicle and spacecraft. Gemini escape means are provided by ejection seats much like those used in present-day, high-performance aircraft. Studies to date show that such seats will be suitable for Gemini because of the much lower explosive yield of the storable hypergolic fuels used in Titan II, as compared to the yield of the cyrogenics used in other launch vehicles.

FUEL

Hypergolic fuel is self igniting; it ignites immediately upon contact with the oxidizer. No ignition problems occur. Nitrogen tetroxide (N_2O_4), the oxidizer, has replaced the liquid oxygen (LOX). This is a toxic gas and requires specific handling qualities; it forms nitric acid when it comes in contact with water of any kind. The fuel is monomethol hydrazine. Both the fuel and the oxidizer are toxic. The fuel will burn the lung membrane, and the oxidizer will burn the skin.

Hypergolic fuel has many dividends, some of which are: automatic ignition when the fuel and oxidizer are spurted together from propulsion chamber orifices, storable for several days within the missile, high specific impulse (thrust per pound), and maximum versatility.

Hypergolic fuel is easy to work with, although personnel handling the fuel wear specially designed suits which completely enclose them and which have self-contained oxygen supplies.

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At launch, the Titan II emits a small, white flame and a rosy cloud rather than orange flames and billowing clouds of smoke. The noise level at launch is about the same as that of the Atlas. At staging, the Titan II second stage is ignited, and the first stage separates completely. Thus, it is efficient as a launch vehicle. All the Atlas engines are ignited on the ground prior to launch.

Both the Gemini adapter section and the Agena engine will also be powered with hypergolic fuel. Hydrogen peroxide will not be used for Gemini or Agena thrust jets, since it is considered too unstable for long periods of time.

Should trouble develop prior to insertion of the Gemini craft into orbit, an explosion of the hypergolic fuel would be less violent. It would be more of a burning than an explosion, giving the astronauts time to eject themselves away from the fireball.

ESCAPE SYSTEM

The ejection seat escape system will be as reliable as the Mercury escape tower system. Either the pilot (spacecraft commander) or the co-pilot (crew) can fire both ejection seats by pulling the "D" ring at his knee. There is no automatic eject device. Normally, the pilot will give the order for ejection; if he is unable, the co-pilot can perform the job.

With the new escape system, it will be possible for the pilot to do his own abort. The Mercury-Atlas system has an abort-sensing device to operate the escape tower automatically. The Gemini system will give the astronaut

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the feeling that he is really "piloting" the spacecraft. This is one of the biggest advances over the Mercury program. It is an attempt to return to the manual mode of flight to give the pilot control over his mission.

While the Mercury spacecraft has a bolted-on hatch with a detonating fuse for explosive removal, the Gemini craft will have two large hatches and a means for opening them and holding them open even under maximum dynamic pressure; there will be enough clearance for both of the pilots to be ejected.

The ejection seats will eject the astronaut anywhere from off-the-pad to more than 60,000 feet. After reentry, unlike the escape tower, the seat system can be used for ejection in the event that trouble develops with the paraglider landing recovery system.

The catapult seat rockets will eject the astronauts at an angle of 15 degrees up from horizontal to an altitude of about 500 feet from the ejection level and to a distance of about 1,000 feet out from the launch vehicle. During ejection, each man will be restrained in his pressure suit and in his restraint couch. A personal oxygen supply will be sufficient for each astronaut until safe altitude is reached in the event of a high altitude abort.

ADAPTER SECTION

The Gemini-Titan adapter section will be carried into orbit with the spacecraft; it will house the fuel cells, the main oxygen supply, the maneuvering control system, the retrorockets, etc. The adapter section itself is 90 inches long, 90 inches in diameter at the top (base of the spacecraft) and 120 inches in diameter at the lower end (top of the launch vehicle).

After the Titan II launch vehicle has taken the Gemini spacecraft to orbital altitude, pyrotechnic devices such as shape charges which actually cut through the metal will be used for separating the launch vehicle from the adapter section of the spacecraft.

Fuel cells will be one of the new developments in the Gemini program; these will provide the main source of electricity and part of the water supply during orbital flight. The cells combine oxygen and hydrogen to produce electricity and water. These fuel cells will -- as listed above -- be housed within the adapter section and will weigh far less than the batteries they replace.

Water from the fuel cells and perspiration collected during the flight will comprise the water supply. Perspiration will be condensed out of the air and will be purified when passed through charcoal for deflavoring of odor, etc. Excess water will be discharged into space via a water boiler.

An array of silver zinc batteries will be contained within the spacecraft to provide power -- since the adapter section will be jettisoned prior to reentry -- for the reentry, landing and post-landing phases of the mission. These batteries also serve as an emergency power source during the orbital phase.

The adapter section will contain the maneuvering control systems to be used in space. Other systems located in the small end of the spacecraft provide the retro attitude and reentry control. The systems are completely dual and give redundancy for this operation. Each system in the small end will be independent and will have eight nozzles; the system in the adapter section will be used during the docking phase and to make small orbital plane changes.

RETROROCKET SYSTEM

Just prior to initiation of the reentry process after the Gemini mission,

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the lower half of the adapter section will be severed by an explosive device to expose the retrorockets housed in the top half of the adapter section.

The retrorocket system will provide the means of slowing the Gemini spacecraft to permit its reentry into the Earth's atmosphere. Solid propellant rockets will fire in ripple fashion upon a signal by the crew or by an automatic device within the spacecraft; this device will be armed by the crew. The retrorocket system may also be used to separate the spacecraft from the launch vehicle in the event of launch abort.

After employment of the retrorockets, this remaining section of the adapter unit will be jettisoned, leaving the heat shield exposed for reentry.

As has been noted above, very few of the Gemini systems will be entirely automatic. There will be more dependence upon man than in the Mercury flights. A horizon sensor of the infrared-detecting type, however, will be almost entirely automatic. This sensor will sense spacecraft roll and pitch attitudes with respect to the Earth's horizon. The sensor will provide the basis for attitude reference throughout the mission. By making this system automatic (like an aircraft autopilot), fuel will be conserved and pilot work will be diminished.

A gyro system for attitude control during reentry will also be automatic to aid in relieving the astronaut of some of the strenuous maneuvers required to control the possible violent actions of the craft during reentry.

There will be four phases of the Gemini rendezvous mission: the launch phase when the orbital plane and orbital phase must be controlled; the midcourse phase after launch and prior to rendezvous when plane and phase maneuvers will be necessary; the terminal phase for final spacecraft and target vehicle docking; and the post docking phase when the Agena engine will be used for checkout, maneuvers, navigation and other experiments that may be required.

Some of the life support systems to be studied during the mission include toxicity studies to determine effects of man's living in a closed environment with certain atmospheric mixtures; development of closed systems, self-generating systems, etc.; crew equipment development (pressure suit primarily); waste management and effect on weight and space; crew medical selection and monitoring; biological instrumentation development for man as an integrated part of the system and the development of medical monitoring techniques and keeping the individuals in good muscle tone; and medical data collection analysis.

DATA

Improved data-gathering techniques and procedures are being devised for the Gemini program. Following each Mercury flight, an enormous quantity of flight data has been recorded onboard the vehicle during the mission. It has been a tedious and time-consuming operation to reduce and evaluate this information and to prepare the voluminous reports on the mission. Mercury experience has made the new techniques possible.

For follow-on programs, Manned Spacecraft Center scientists and engineers plan to use equipment which will print data only for periods of flight during which systems operations events occur out of the planned limits of the mission. This will not reduce overall knowledge of mission progress, since flight information will continue to emanate to ground stations from the spacecraft via telemetry.

TRACKING

The Mercury Worldwide Tracking Network will be used for the Gemini program for tracking, telemetry, command, control and communication. Existing network stations will be heavily relied upon; final requirements are not yet completed, but they are being developed as a result of the heavy study effort in both the Gemini and Apollo programs. It is foreseen that both the rendezvous requirements and the maneuver experiments will require specialized instrumentation to provide expanded capability.

The network now consists of 18 stations around the world, including two ships at sea. Sites linked across the Atlantic are: Cape Canaveral, Grand Bahama Island, Grand Turk Island, Bermuda, and Grand Canary Island. Stations in the Continental United States are at Point Arguello, California; White Sands, New Mexico; Corpus Christi, Texas; and Eglin, Florida. Overseas stations include Bermuda; Grand Canary; Kano, Nigeria; Zanzibar; Muchea and Woomera, Australia; Canton Island in the Pacific; Kauai Island, Hawaii; and Guaymas, Mexico.

All the tracking stations now have two-way communications with orbiting Mercury spacecraft; some have both tracking and telemetery receiving capability, while others have only one or the other of tracking and telemetry receiving capability. Some of the stations also have the capability of sending instrument-command communications to the spacecraft. For example, Muchea, Australia, has only telemetry receiving equipment, while the Woomera, Australia, station can track the vehicle, obtain telemetered information and communicate with and command the spacecraft. Canton Island provides telemetering and communications only. Hawaii has telemetry and radar, and Point Arguello has telemetry, radar, communications and a command transmitter.

The Mercury Tracking Network, providing a belt of stations circling the entire world, is the first truly global network. The uniqueness of the Mercury system comes from the need to be in close contact with the vehicle, to have data available in "real" time for quick "look," and to have enough facilities in the right place to cope with any emergency that might arise.

The worldwide Mercury Tracking Stations were installed in less than two years under tremendous pressure and under the most trying conditions. If stretched end to end, the submarine cables, telephones lines, and teletype circuits would circle the globe six times.

The Mercury-Atlas 4 flight of September 13, 1961, which was a successful attempt to place a Mercury spacecraft into orbit carrying a "mechanical astronaut," was the first actual testing of the network.

The communications network funnels through a master nerve center -- Goddard Space Flight Center -- to Cape Canaveral for "real" time study by flight controllers in Mercury Control Center.

For Project Mercury, NASA had to provide contact and communications for the spacecraft for five out of every 15 minutes -- only for four and one-half hours, the duration of the mission. For one-day Mercury missions, the current requirements are to provide only one contact per orbit, but there are 16 to 18 orbits during the 24 hours.

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The movement of the mid-Atlantic tracking ship to a point in the Pacific west of Chile and the shifting of the Indian Ocean ship to a point near Madagascar -- together with ground-based stations already operational -- would meet the requirement of communicating at least once each orbit. In addition, certain tracking sites not now having the capability of sending instrument commands to the vehicle will have that capability installed. This augmentation is already underway.

For the Mercury network, the prime contractor was Western Electric, aided by subcontractors which included Bell Laboratories, International Business Machines (IBM), and Bendix. Bendix has also been a major contractor in the building of the Minitrack stations.

The NASA Goddard Space Flight Center on April 26, 1962, graduated the first group of Project Mercury personnel who completed a newly established curriculum on tracking and systems monitoring at the NASA Wallops Stations, Wallops Island, Virginia. The seven graduates represented personnel from both NASA and the Department of Defense contractors. Directed by the Goddard Center, the Mercury Network training program consists of specialized courses to support manned space flight missions.

PRESSURE SUIT

A new pressure suit development program is underway in connection with the Gemini program. Study contractors (B.F. Goodrich, Arrowhead Products and Protection, Inc.) are well underway with the suit. These suits will have removable arms and legs and a fabric helmet which can be opened and folded aside for astronaut comfort (a "shirt-sleeve" environment) and exercise.

During the Gemini mission, the pilots -- one at a time -- will unlatch his pressure tight hatch, open, and climb out of his cockpit into space for up to 15 minutes, protected all the while by the life-supporting atmosphere within his pressurized suit, augmented by an oxygen back pack. What experiments they might attempt while outside the spacecraft have not been determined at this early date.

Other NASA research centers are developing special torqueless tools to be used by the astronauts to perform mechanical and other type work in space, but when the astronauts will actually test these has not yet been documented.

Separate circuits for the suits and the cabin will be provided just as in the Mercury system.

COMPUTER

Another innovation to be used for the Gemini spacecraft will be an airborne, manual-feed electronic computer which will weigh about 65 pounds and will require only about one cubic foot of space outside the crew compartment. The computer will operate like an IBM 704 and will be capable of taking 4,096 bits of information programmed in. Through the use of this instrument, the astronaut can determine at any time his impact point should he initiate reentry processes. He can also determine what corrections he should make to land at any desired point. The computer will further be used during rendezvous and docking to determine the amounts and direction of spacecraft thrust to be expended at the proper time to automatically or manually guide the spacecraft toward the target.

After retro firing, a sensor in the computer will determine each conditional aspect and supply landing site information. This information will be returned in real time. The astronaut will have the keyboard in front of him to manually feed the variables into the machine to have his desired information returned.

This computer requires very little extra training - only a matter of hours. Manned Spacecraft Center engineers compare the operation of this instrument with the operation of an adding machine.

RADAR UNIT

The radar unit aboard the Gemini spacecraft will have a range of up to 250 miles. After finding the Agena target in orbit, the astronauts will lock onto it with radar until the two vehicles close within about 50 to 20 miles of each other. Through the use of this radar unit, the astronauts will receive such information as bearing, range, distance closing rate, and direction. Somewhere between 50 and 20 miles of the Agena, the astronauts should be able to detect the high-intensity, flashing light from the beacon aboard the Agena vehicle. Optical tracking will be employed when the range has been closed. From that point, the pilots may use a combination of automatic and manual control or manual control alone for final rendezvous maneuvering.

The radar antenna cover is jettisoned soon after launch. The radar equipment itself will be jettisoned after reentry but before paraglider deployment.

GUIDANCE PLATFORM

An inertial guidance platform aboard the Gemini craft -- similar to those aboard many military vehicles -- will be a four-gimballed platform. It has necessarily been added during planning phases because of the rendezvous experiment. It can be used to retain attitude reference in event of spacecraft tumbling or to conserve fuel by allowing the spacecraft to tumble, without losing attitude control. Fuel can be conserved by letting the spacecraft tumble, rather than demanding continuous control of exact attitude. The purpose of the four axis gimballed platform is to allow tumbling of the spacecraft without having to lock the gyros and still not throw them off axis (as in the case of one with three axes). Horizon scanners are provided for occasional corrections.

This inertial guidance system will also serve as an attitude reference and as a means of navigation during rendezvous, reentry and paraglider landing. The space-stabilized platform will operate in conjunction with the general purpose digital computer, and will also back up the launch vehicle guidance during launch.

The guidance platform is about ten inches long, eight inches wide and weighs about 130 pounds. It is located outside the crew compartment.

ASTRONAUT TRAINING

Problems in the area of additional astronaut selection and training planning have not been great and are felt to be well in hand. An announcement concerning these astronauts is due this fall (1962).

One of the Gemini flight trainers will be located at the Manned Spacecraft Center's new site at Houston, where the new Mission Control Center will be positioned. (The official announcement on the establishment of the Mission Control Center at MSC was made by NASA Headquarters on July 20, 1962.) This

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Control Center will include -- for one thing -- a mock-up of the whole Gemini craft with actual switches, fuses, etc., tied in with the control center's computer network.

Plans for centrifuge training are now fairly concrete. The Johnsville (Pennsylvania) centrifuge will continue to provide basic aeromedical data regarding the permissible g loads to which man may be subjected. But once the mission is determined, the men and equipment must be exercised together; this will be done at the Manned Spacecraft Center in Houston.

These are three centrifuges proposed by NASA:

1. Manned Spacecraft Center's centrifuge will primarily be for astronaut training and test purposes under environmental conditions encountered in actual space flight in conjunction with actual flight simulations conducted by the adjacent Mission Control Center.

2. A centrifuge at the NASA Ames Research Center (California) would be utilized for advanced research and development of systems, components, and equipment to be used in spacecraft subsequent to the Apollo systems. Intensive research is required in order to assure availability of components for spacecraft that will explore the solar system later in this century

3. A smaller centrifuge at Goddard Space Flight Center (Greenbelt, Maryland) would be used for tests of unmanned payloads under launch conditions to assist in assuring reliability of these systems during actual flight.

These three centrifuges will provide essential tools for the rapidly expanding and fast-paced space program to which NASA is committed.

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Astronauts will spend isolation periods up to two weeks in test chambers to train for long-duration missions. One of the most important parts of the experimentation will be to determine whether or not they can stand the isolation -- even with another person or persons -- for such long periods.

MISSION CONTROL CENTER

The Manned Spacecraft Center's Mission Control Center will contain a similar operating team as handles the Mercury launches from the Mercury Control Center at Cape Canaveral. The missions will be headed by a Mission Director, who most likely will also be the Assistant Director for Operations in the Manned Spacecraft Center's organization. There will be a Launch Director responsible for flight control, trajectory assessment, systems monitoring, medical monitoring, voice communications, reentry, and emergency situations. A Network Director will be stationed there to direct tracking, communications and data acquisition. A Recovery Director will be in charge of search, location and recovery.

LANDING

NASA has also had to consider both the ability to land the Gemini spacecraft safely on land rather than in water and the ability to land at a preselected point on the Earth's surface. Both of these ends must be achieved before NASA can feel that the terminal phases of space flight have been satisfactorily developed.

The achievement of point-landing capability requires that throughout the reentry phase of flight the pilot must be able to apply controlled lift to the vehicle to change its course and correct navigational errors, winds, etc. In

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Mercury, it was felt that this lift capability was not needed. Since Mercury was an initial exploratory program, NASA could satisfactorily account for recovery from the pre-planned landing point by disposition of the recovery force's ships and aircraft. This course of action assured NASA designers of the quickest and simplest means of getting on with the job.

In Apollo, however, this control of lift during reentry will be required to permit safe entry into the atmosphere at the very high speeds associated with flight to the moon; thus, the Gemini spacecraft will be built with an offset center of gravity so that it will tend to trim at some definite value of lift rather than at zero lift as in Mercury. The direction of this lift vector and thus the direction of the course corrections will be controlled by rolling the spacecraft by means of small reaction jets activated by the pilot's hand controller. With such control, the Gemini pilot should be able to reach any landing point within about 100 miles to either side of zero-lift line of flight and several hundred miles up or down range from the zero-lift landing point.

Even with controlled lift during reentry, if a parachute is used for the final stages of letdown, the crew will still face the problems of wind drift in the lower atmosphere, of avoiding local hazards such as rocks, cliffs or trees, and of reducing the final landing shock.

PARAGLIDER

To provide solutions to primary landing system problems on Gemini, the 63-foot ringsail parachute used with the Mercury spacecraft will be replaced with a "Rogallo Wing" or paraglider, a steerable device with inflatable booms connected with a coated synthetic fabric and with a wing-spread of 43 feet and a length of 30 feet.

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Until ready for use in the lower atmosphere, the wing will be carried folded and uninflated in a canister approximately ten cubic feet in size in the cylindrical section of the spacecraft. When the spacecraft has completed its entry and has slowed to a subsonic speed at about 60,000 feet,a drogue gun will remove the top of the canister, and a small drogue chute will be deployed. The paraglider will be deployed at about 50,000 feet in a collapsed shape. It will then be released into flight shape, fully inflated, and will be operational at about 42,000 feet. The pilot will then have the ability to glide to a preselected landing strip, counteract rather high winds that would blow a parachute off course, avoid local hazards, and finally flare out to reduce the speed of his vertical descent, and to land with a reasonable speed of about 45 knots on the skid-type landing gear.

The Gemini landing gear will consist of a nose skid and two outrigger skids for stability and support. The nose skid will be extended during paraglider deployment, but the pilot will extend the rear skids. The landing -- although at a low speed -- will resemble that of the X-15 craft.

The paraglider is controlled in pitch and roll modes; the astronauts's movement of the hand-controller, which actuates gas-operated cable reels, will move the spacecraft relative to the paraglider; this will shift the center of gravity of the assembly forward, aft or sideways to permit the paraglider to dive, climb, or bank. No rudder control is necessary.

The alternate or backup system is a large parachute. If this chute is used over land, the astronauts will eject themselves prior to the landing of the spacecraft. Impact forces will be too great for the astronauts but

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low enough to let the vehicle down without serious damage.

Much theoretical study has been made on the paraglider landing technique at the NASA Flight Research Center (California). During January 1962, a manned paraglider built by that Center was launched by automobile tow from a dry lake. This test was one of many leading to the development of the inflatable paraglider, for use in the Gemini program.

The paraglider development is under contract to the Space and Information Systems Division of North American Aviation. Design competition was started late in 1961, and North American was judged to have the best approach to the problems concerned.

Now proceeding with the test phase, North American is building one-half and full-scale Gemini boilerplate models for remote flying by ground flight controllers. An airborne flight controller will fly the vehicle after helicopter drop, then turn the control over to pilots on the ground.

Full-scale drops employing the paraglider are expected to begin sometime late this fall. Later, production spacecraft will be carried aloft by USAF C-130's and dropped manned from some 30,000 feet altitude. The paragliders will be deployed and the astronauts will fly the vehicles back to predetermined landing sites.

Many such drops are planned for training purposes with the paraglider. These trainers will not be boilerplate models; they will be production type vehicles with full guidance systems aboard. Personal parachutes will be carried in the event that ejection becomes necessary. If trouble does develop during this training, the paraglider will be jettisoned -- just as in actual flight -- and the astronauts will eject themselves to safety.

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Both theoretical and developmental study has been made on the paraglider at the NASA Langley Research Center (Virginia) during the past several years under the direction of Francis M. Rogallo, inventor of the paraglider and Head of Langley's 7 X 10-Foot Wind Tunnel Section.

Also, much theoretical study has been made by Langley on the rendezvous technique - both earth and lunar rendezvous. Manned Spacecraft Center scientists and engineers are taking full advantage of Langley's supporting theoretical and research work.

FLIGHT SCHEDULE

Under present plans, two-man flights should begin during the 1963-64 period, starting with an unmanned, parachute-recovery flight from Cape Canaveral for tests of overall launch vehicle-spacecraft compatibility and systems engineering. The second, third and fourth Gemini flights will be manned for long-duration missions.

The first manned Gemini-Titan flight will be an 18-orbit mission, while the second will be a two-week trip.

Rendezvous and docking missions will begin with the fifth Gemini flight. The fifth mission will not be a long-duration flight; after rendezvouing, docking and preplanned maneuvering and experiments, the crew will prepare for reentry.

ADDITIONAL ASTRONAUTS

Problems in the area of additional astronauts selections and training planning have not been great and are felt to be well in hand.

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The Manned Spacecraft Center's current astronauts are slated to serve as senior pilots for this program. The nine new test pilots may serve as crew members (co-pilots) for the Gemini missions. They should be completely trained in time for such flights. Qualifications for the nine test pilots were less demanding in pilot-time requirements, but more demanding in that the age limit was lowered to 35 and a degree in science or engineering was listed as necessary.

For post-Gemini, work on the Apollo program has been underway since early 1960. A small team of MSC engineers was set up at that time to define the project mission and to develop working guidelines for its conduct. All of the NASA Research and Space Flight Center resources, as well as industrial teams, have been brought into the program to assure a solid technical base.

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